EXERCISES

For more practice, see *Extra Practice*.

Practice and Problem Solving

A Practice by Example

Example 1 (page 641)

Describe in words the translation represented by each vector.

1. $\langle 2, 5\rangle$ **2.** $\langle 4, 1\rangle$ **3.** $\langle -3, 8\rangle$ **4.** $\langle 7, -2\rangle$ **5.** $\langle -1, -6\rangle$

Describe each translation using an ordered pair.

6. 0 units to the right, 4 units up

7. 2 units to the left, 1 unit down

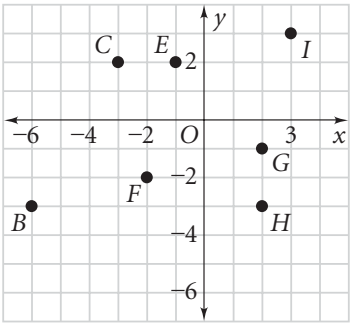
8. 3 units to the left, 6 units down

9. 8 units to the right, 10 units up

In the diagram, find the image of *F* under the translation described by the given vector.

10. $\langle -1, 4\rangle$ **11.** $\langle 4, -1\rangle$ **12.** $\langle 4, 1\rangle$

13. $\langle 1, 4\rangle$ **14.** $\langle 5, 5\rangle$ **15.** $\langle -4, -1\rangle$



Find the vector that describes each translation.

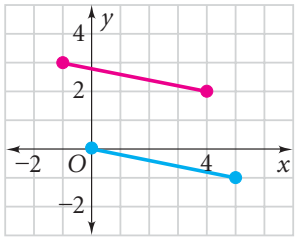
16. $G \to H$ **17.** $B \to E$ **18.** $I \to C$

19. $H \to G$ **20.** $E \to B$ **21.** $C \to I$

Example 2 (page 642)

In Exercises 22–25, the blue figure is a translation image of the red figure. Write a rule to describe each translation.

22.



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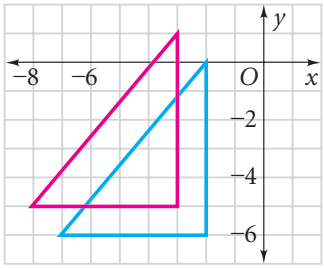

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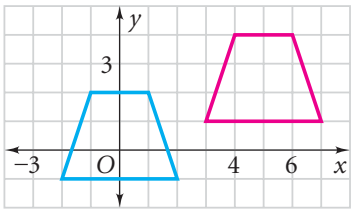

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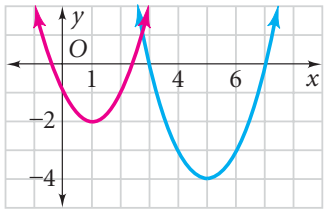
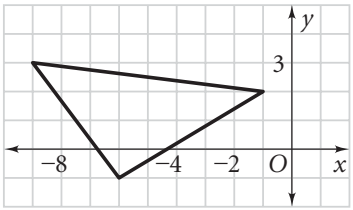


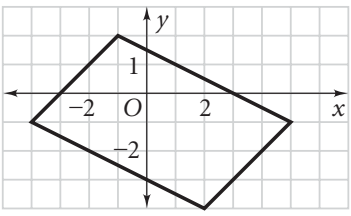
Example 3 (page 642)

Use matrices to find the image of each figure under the given translation.

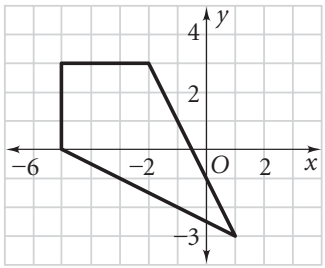
26. translation $\langle 3, 2\rangle$



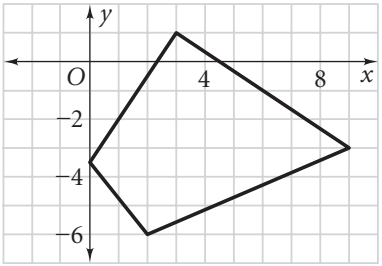
27. translation $\langle 5, -1\rangle$



28. translation $\langle -2, 5 \rangle$



29. translation $\langle -4, 3 \rangle$



30. $\triangle ACE$ with vertices $A(7, 2)$, $C(-8, 5)$, $E(0, -6)$; translation: $\langle -9, 4 \rangle$

31. $\triangle PUN$ with vertices $P(1, 0)$, $U(4, 6)$, $N(-5, 8)$; translation: $\langle 11, -13 \rangle$

32. $\square PLAT$ with vertices $P(-2, 0)$, $L(-1, 1)$, $A(0, 1)$, $T(-1, 0)$; translation: $\langle 1, 0 \rangle$

33. $\square NILE$ with vertices $N(2, -5)$, $I(2, 2)$, $L(-3, 4)$, $E(-3, -3)$; translation: $\langle -3, -4 \rangle$

Example 4 (page 643)

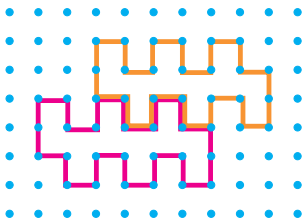
34. Emily left Galveston Bay at the east jetty and sailed 4 km north to an oil rig. She then sailed 5 km west to Redfish Island. Finally, she sailed 3 km southwest to Spinnaker Restaurant.
a. Draw vectors on graph paper that show her journey.
b. Describe where Spinnaker Restaurant is from where Emily started.

35. Nakesha and her parents are visiting colleges. They leave their home in Enid, Oklahoma, and drive to Tulsa, which is 107 mi east and 18 mi south of Enid. From Tulsa, they go to Norman, 83 mi west and 63 mi south of Tulsa. Draw a diagram to show their trip. Then, tell where Norman is in relation to Enid.

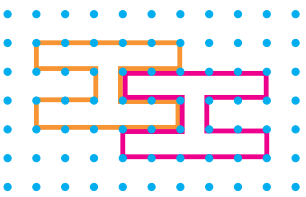
B Apply Your Skills

The orange figure is a translation image of the red figure. Write a rule to describe each translation.

36.



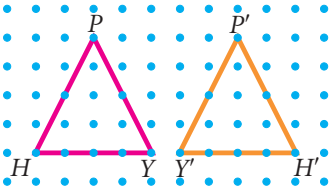
37.



38. Photography When you snap a photograph, a shutter opens to expose the film to light. The amount of time that the shutter remains open is known as the shutter speed. For the photograph at the left, the photographer used a long shutter speed. It created an image that suggests a translation. Draw a picture of your own that suggests a translation.

39. Coordinate Geometry $\triangle MUG$ has coordinates $M(2, -4)$, $U(6, 6)$, and $G(7, 2)$. A translation maps point M to $M'(-3, 6)$. Find the coordinates of U' and G' under this translation.

40. Coordinate Geometry $\square ABCD$ has vertices $A(3, 6)$, $B(5, 5)$, $C(4, 2)$, and $D(2, 3)$. The figure is translated so that the image of point C is the origin.
a. Find the vector that describes the translation.
b. Graph $\square ABCD$ and its image.



41. Writing Is the transformation at the right, $\triangle HYP \rightarrow \triangle H'Y'P'$, a translation? Explain.

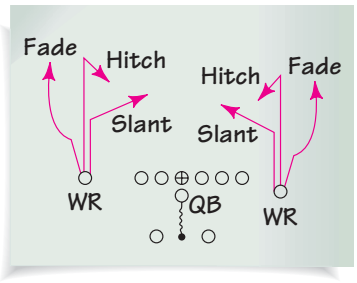
Find a single translation that has the same effect as each composition of translations.

42. $\langle 2, 5\rangle$ followed by $\langle -4, 9\rangle$

43. $\langle -3, 7\rangle$ followed by $\langle 3, -7\rangle$

44. $\langle 1, -3\rangle$ followed by $\langle 5, 2\rangle$

45. $\langle 12, 0.5\rangle$ followed by $\langle 1, -3\rangle$



46. Football The play chart at the left shows routes that a wide receiver (WR) can choose to run when the team is in the "red zone" (within 20 yards of the goal line). The quarterback (QB) drops back two steps to make the pass to the wide receiver.

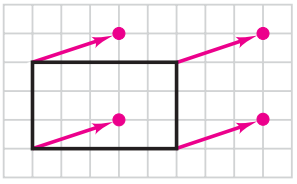
a. Suppose a wide receiver runs a slant. Describe the two translations involved and the composition of those two translations.

b. Describe the two intended translations of the football during the play, and the composition of the translations.

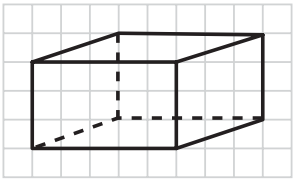
c. What is the intended outcome of the two compositions in parts (a) and (b)?

Geometry in 3 Dimensions **Use each figure, graph paper, and the given vector to draw a three-dimensional figure.**

SAMPLE Use the rectangle and vector $\langle 3, 1\rangle$ to draw a box.

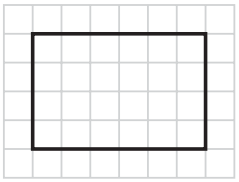


Step 1



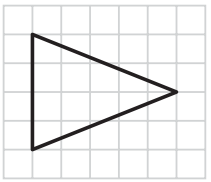
Step 2

47.



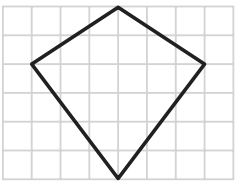
Use $\langle 2, -1\rangle$.

48.



Use $\langle -2, 2\rangle$.

49.



Use $\langle -3, -5\rangle$.

50. Open-Ended You work for a company that specializes in creating unique, artistic designs for business stationery. One of your clients is Totter Toy Co. You have been assigned to create a border design for the top of their stationery. Create a design that involves translations to present to your client.

Challenge

51. a. $\triangle ABC$ has vertices $A(-2, 5)$, $B(-4, -1)$, and $C(2, -3)$. Find the image of $\triangle ABC$ under the translation $\langle 4, 2\rangle$.

b. Show that the images of the midpoints of the sides of $\triangle ABC$ are the midpoints of $\triangle A'B'C'$.

52. Writing Explain how a parallelogram could be defined in terms of translations.

Standardized Test Prep

Multiple Choice

53. What is the image of $(6, -2)$ under the translation $\langle -5, -8 \rangle$?
A. $(14, 3)$ **B.** $(-2, -7)$ **C.** $(11, 6)$ **D.** $(1, -10)$

54. The point $(5, -9)$ is the image under the translation $\langle 3, 2 \rangle$. What is the preimage?
F. $(2, -11)$ **G.** $(8, -7)$ **H.** $(2, -7)$ **I.** $(8, -11)$

55. What vector describes the translation of 4 units up and 12 units left?
A. $\langle 12, 4 \rangle$ **B.** $\langle -12, 4 \rangle$ **C.** $\langle -12, -4 \rangle$ **D.** $\langle 12, -4 \rangle$

56. What vector describes the translation from $(0, -3)$ to $(9, 5)$?
F. $\langle -9, -8 \rangle$ **G.** $\langle -9, 8 \rangle$ **H.** $\langle 9, -8 \rangle$ **I.** $\langle 9, 8 \rangle$

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57. $\triangle XYZ$ has vertices $X(-5, 2)$, $Y(0, -4)$, and $Z(3, 3)$. What are the vertices of the image of $\triangle XYZ$ under the translation $\langle 7, -5 \rangle$?
A. $X'(2, -3)$, $Y'(7, -9)$, $Z'(10, -2)$ **B.** $X'(-12, 7)$, $Y'(-7, 1)$, $Z'(-4, 8)$
C. $X'(-12, -3)$, $Y'(-7, -9)$, $Z'(-4, -2)$ **D.** $X'(2, -3)$, $Y'(10, -2)$, $Z'(7, -9)$

Short Response

58. $\triangle ABC$ has coordinates $A(0, -3)$, $B(-4, -2)$, and $C(2, 1)$. A translation maps point B to $(10, -3)$.
a. What vector describes the translation?
b. What are the images of A and C under this translation?

Mixed Review

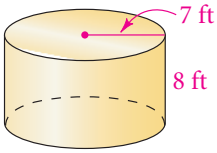
Lesson 12-1

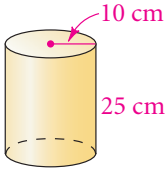
$\triangle BIG$ has vertices $B(-4, 2)$, $I(0, -3)$, and $G(1, 0)$. Draw $\triangle BIG$ and then its reflection image in the given line.

59. the y-axis **60.** the x-axis **61.** $x = 4$

Lesson 10-5

Find the volume of each cylinder in terms of π.

62.


63.


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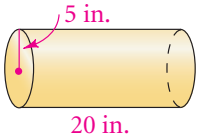
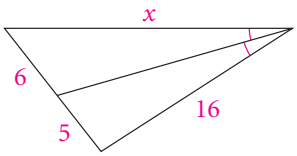


Lesson 8-5

Solve for x.

65.


66.